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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
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SCIENTIFIC PEER REVIEW COMMENTS AND STAFF RESPONSE

The following comments address the external scientific review of the Total Maximum Daily Load for Fecal Coliforms (TMDLs) in Pajaro River Watershed waters including, Pajaro River, San Benito River, Llagas Creek, Tequisquita Slough, San Juan Creek, Carnadero/Uvas Creek, Bird Creek, Pescadero Creek, Tres Pinos Creek, Furlong (Jones) Creek, Santa Ana Creek, and Pachecho Creek. The external scientific reviewer was Stefan Wuertz, Ph.D. of the University of California at Davis, who submitted his review in a document (submittal) dated July 30, 2008, and received via email in the Central Coast Water Board's office on August 10, 2008.

Central Coast Water Board staff asked the reviewer to determine whether the scientific portion of the TMDLs was based upon sound scientific knowledge, methods, and practices. We requested the reviewer make this determination for several issues that constituted the scientific basis of the TMDLs. The issues are presented below, with the reviewer's comments and staff's response.

On balance, the reviewer provided overall supportive assessments of the proposed TMDL as demonstrated in this statement, from the "General Conclusions" section of the submittal:

> "The proposed measures to reduce allocations from controllable sources are supported scientifically and may be adequate to achieve necessary load reductions and compliance with a mass-based TMDL." (Dr. Stefan Wuertz, page 10, "General Conclusions")

I. Scientific Peer Review of the TMDLs for Pathogens in Aptos Creek, Valencia Creek, and Trout Gulch. All of the following comments are provided by Professor Stefan Wuertz.

Modification of the Aptos Creek Watershed Prohibition

1. Reviewer's comment: Reviewer finds the modification of the Aptos-Soquel Creek Watershed Prohibition as planned by the Water Board scientifically sound and balanced with one exception. The allocation of FIB [fecal indicator bacteria] from

natural sources constitutes a significant load and should be accounted for in the proposed TMDL. If it is expected to remain unchanged because the Water Board has no regulatory authority over waste discharges from wildlife, then calculations should be done showing to what extent other waste loads need to be reduced to meet the TMDL allocations.

Staff response: Staff did not include calculations to show what extent other waste loads need to be reduced in order to meet the TMDLs because staff concluded that all controllable sources should be reduced or eliminated to the maximum extent practicable, or to the point that the numeric target is achieved. This approach is necessary because the precise contribution from uncontrollable sources is not known, therefore, the magnitude of reduction of the controllable sources to achieve the numeric target is not known.

Source Analysis

2. Reviewer's comment: Source analysis was partially based on the Source Identification Study by the County of Santa Cruz, Environmental Health Service Water Resources Program (see Section 2 of this review) as well as a variety of other sources detailed in the Final Project Report prepared by staff. The Source Identification Study has been carefully interpreted and ribotyping data for fecal source identification are used mostly to make qualitative assessments of wildlife, livestock, pets and humans as sources of pollution. Stormwater and collection system leaks, blocks and spills are identified as controllable NPS pollution, an assessment that is fully justified by the available data.

   Staff response: Staff agrees with the reviewers comment.

3. Reviewer's comment: Staff also concluded that seasonal variations in water quality data are not a factor in terms of exceedances. This assessment was reached in part because insufficient indicator data were available for the wet season. Reviewer recommends re-visiting the assumption once more monitoring data are in hand. Seasonal influences seem very likely due to different precipitation patterns and flows in the watershed.

   Staff response: Staff will revisit this assumption during the implementation phase of the TMDLs, as the reviewer suggests. Staff acknowledges that seasonal influences due to rainfall are probable. However, the numeric targets and implementations actions will remain the same whether there is seasonal influences or not because the numeric target and TMDLs are based on an enforceable water quality objective.

4. Reviewer comment: The Water Board also estimates that a higher proportion of indicator bacteria are contributed from bird, wildlife and rodent sources than from human sources. Wet season sampling will serve to investigate if the human

sources of fecal contamination increase during wet weather, as suggested in the Final Report. There is uncertainty associated with assigning host-specific loads (see Section 2); and it is important to analyze a sufficient number of colonies per water sample if the ribotyping method is used for MST.

Staff response: Staff agrees with the reviewer's comment regarding the inherent uncertainty in assigning loads based on ribotyping data. Staff used ribotyping data, along with other data and information, to develop a source analysis of fecal indicator bacteria. Staff did not, however, develop load-allocations and assign them to responsible parties based on the ribotyping data. Therefore, the uncertainty is not transferred to responsibility on an allocated load basis.

Numeric Targets

5. Reviewer comment: FIB [fecal indicator bacteria] water quality objectives in terms of mean and maximum fecal coliforms and *E. coli* and *Enterococcus* concentrations for REC1 waterbodies and the US EPA Ambient Water Quality Criteria for Bacteria (1986) are proposed as numeric targets. In the absence of real pathogen data or sufficient scientific knowledge about the public health risks associated with FIB in recreational waters impacted by NPS pollution these targets are reasonable.

   Staff response: Staff notes the reviewers comment and agrees that, in the absence of real pathogen data, fecal indicator bacteria should be used.

   Also, implicit in the reviewers comment is the fact that FIBs are not always good indicators of real pathogens. The scientific community is uncertain whether any one of the traditionally used FIBs (fecal coliform, E. coli, Enterococcus) are any better indicators of pathogens than the others. The Water Quality Control Plan (Basin Plan) contains numeric objectives for fecal coliform that are used as FIBs. Therefore, since no single FIB stands out as a superior indicator of pathogens over the others, and since current water quality objectives use fecal coliform as the indicator, staff concluded that fecal coliform should be used as the indicator for the TMDLs. Staff removed E. coli *and* enterococcus *as numeric targets from the TMDL Project Report, leaving fecal coliform as the FIB. Staff made this decision based on current information and after consultation with a number of scientists (including Kenneth Schiff of the Southern California Coastal Water Research Project Authority) and State Water Board staff, as well as information from workshop findings and journal articles.*

TMDL targets and allocations

6. Reviewer comment: Reviewer does not follow the rationale presented by the Water Board to set TMDLs as the same set of concentrations as the numeric

targets. Such an approach would seem to ignore the mixing effects of receiving waters and different sources of influents and the overall influence of different flows on the indicator concentrations. It is also unclear how the considerable load from natural (largely uncontrollable) sources will be accounted for.

Staff response: Staff acknowledges that the given approach does not account for mixing effects of receiving water and different flows; doing so might take into account dilution affects, thereby potentially allowing a greater load allocation. Therefore, the proposed TMDLs, which do not take into account potential dilution, are a more conservative approach, thereby creating an implicit margin of safety.

Further, there is inherent inaccuracy in laboratory methodologies that determine fecal indicator bacteria concentrations, so staff concludes that conservative TMDLs are appropriate.

Staff also recognizes that for many pollutants, TMDLs are expressed on a mass-loading basis (e.g., pounds per day, organisms per day). For fecal indicators, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001):

> For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For fecal indicators, however, TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(i): "TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure," and NPDES regulations at 40 CFR 122.45(f): "All pollutants limited in permits shall have limitations...expressed in terms of mass except...pollutants which cannot appropriately be expressed by mass." – *from USEPA "Protocol for Developing Pathogen TMDLs", 2001*

Expressing the TMDL as a concentration equal to the water quality objective ensures that the water quality objective will be met under all flow and loading conditions. Expressing the TMDL as a concentration equal to the water quality objective ensures that the water quality objective will be met under all flow and loading conditions

The density of fecal indicator organisms in a discharge and in the receiving waters is the technically relevant criterion for assessing the impact of discharges, the quality of the affected receiving waters, and the public-health risk (Santa Ana Water Board 1998, San Francisco Bay Water Board, 2006, Central Coast Water Board 2006). Therefore, staff established concentration-based TMDLs and pollutant load allocations, expressed in terms of indicator bacteria densities.

Establishment of a concentration-based, rather than a load-based TMDL has the advantage of eliminating the need to conduct a complex and potentially error-

prone analysis to link loads and expected densities. A load-based TMDL would require calculation of acceptable loads based on acceptable bacterial densities and expected flows, and then back-calculation of expected densities under various load reduction scenarios. This becomes problematic because flows in Pajaro River Watershed waters, are variable and difficult to measure. There are reportedly only six active stream gages in the entire watershed (1,263 square miles), only four of which appear to have data of more than 20 years record. Gages with relatively short length of record are less desirable for statistical analysis. Additionally, few of the tributary waterbodies identified in the proposed TMDL appear to have any flow data. A flow/load duration analysis would inevitably involve a great deal of uncertainty, with no increased water quality benefit. Further, historic or current flow data may not be representative of future conditions in a complex and highly managed hydrologic system such as the Pajaro watershed. Flows within the watershed may fluctuate on a non-seasonal basis due to intensive water management practices.

In short, concentration-based loading capacity TMDLs are deemed more straightforward since they only require measuring concentrations in the waterways and do not require extensive discharge measurements and loading calculations. The TMDLs proposed are based on existing numeric water quality objectives. A concentration-based approach for these TMDLs, simply allocates pollutant loads to sources based upon the pathogen water quality standard. Unlike mass-based load allocations, the concentration-based load allocations do not add up to equal the TMDLs, since the concentrations of individual pollution sources are not additive. Rather, in order to achieve the concentration-based TMDL, it is simply necessary to assure that each source meets the concentration-based overall load allocation.

Finally, the load from uncontrollable sources will be accounted for after such time that all implementation efforts have been exhausted to the maximum extent practicable, leaving the "largely uncontrollable" fraction of fecal coliform indicators.

7. Reviewer comment: It is stated in the Draft Project Report that public health risks are based on organism concentration and that pathogens are not readily controlled on a mass basis. The same argument could be used for other constituents for whom TMDLs are being developed. Perhaps the reluctance to employ loads instead of cell concentrations of fecal coliforms is rooted in the belief that bacteria are emitted from a particular fecal source (like a storm drain or wild animal) and then undergo rapid decay in the environment without leaving a trace, unlike a chemical constituent which may undergo chemical transformation or sorb to particles. On the contrary, bacterial (fecal coliform) cells can persist in the environment and attach to particulates, either in the water column or in the benthos; they will also grow and divide given the right conditions and finally detach..

Staff response: The reviewers comment stems from the fact that concentration based TMDLs are being used, rather than load-based TMDLs. The reasons for using concentration-based TMDLs were noted in the previous staff response. The TMDLs proposed are based on existing numeric water quality objectives, and flow/load duration analysis would inevitably involve a great deal of uncertainty, due to lack of adequate data and watershed specific conditions.

8. Reviewer comment: Further, it seems important to design Pathogen TMDLs that are flexible enough to allow for the use of real pathogen data or microbial source tracking data during the implementation and monitoring stages and that can pinpoint the predicted effects of reductions in specific load allocations.

   Staff response: Staff agrees that tracking real pathogen data (not indicators of pathogens) is preferred. Staff will seize these opportunities when methods and resources needed to monitor pathogenic organisms, at the scale required to develop and implement TMDLs, become available.

Reviewer comment: The EPA Protocol for Developing Pathogen TMDLs (2001) states that "…TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(i) ….." (see page 7-1 in First Edition). However, given the availability of FIB data for the watershed and the many user-friendly statistical and mass balance models developed for TMDL calculations, it is advisable to use the tools available for simulation in the design of Pathogen TMDLs. EPA recommends Load Duration Curves (An Approach for Using Load Duration Curves in the Development of TMDLs, EPA 841-B-07-006, August 2007), a type of cumulative distribution function. The approach involves plotting observed flow rates against the percent of time those values have been met or exceeded. Existing and allowable loads are calculated by multiplying flow values with the measured concentration of FIB and the numerical target, respectively. The method does not lend itself easily to estimating loads from specific sources within watersheds. Mass balance methods, on the other hand, require more data but can be used in situations where a differentiation between direct (e.g. failing septic tanks, sewers, livestock) and diffuse (runoff from land uses) nonpoint sources is not easily made or when there are there are no pronounced seasonal (flow-related) fluctuations.

Additional models developed by EPA are in-stream models that can account for spatial and temporal variation of bacterial loading. A numerical target for a TMDL may be exceeded at certain times and in many cases it is useful to refer to modeling techniques that give a reasonable estimate of the frequency distribution of projected receiving water quality. USEPA has listed continuous simulation, Monte Carlo simulation, and lognormal probability modeling as useful approaches to calculate receiving water concentrations. References are in Protocol for Developing Pathogen TMDLs (2001) and more recent information is available from the EPA TMDL website (http://www.epa.gov/owow/tmdl/techsupp.html).

Staff response: Staff agrees that modeling is useful and informative; it also typically requires more historic data than available, particularly flow data. A load-based TMDL would require calculation of acceptable loads based on acceptable bacterial densities and expected flows, and then back-calculation of expected densities under various load reduction scenarios. This becomes problematic because flow data is limited in Pajaro River Watershed waters, for other reasons noted in staff comments above. Staff will consider using modeling approaches during the implementation phase if resources and data become available. Modeling during the implementation phase may inform the progress of achieving the TMDLs and result in a more precise distinction between uncontrollable and controllable sources.

Reviewer comment: The main advantage of expressing Pathogen TMDLs in terms of organism loadings is that the effect of various source load reductions can be estimated and allocation scenario loadings calculated. The Water Board has proposed that the load allocations for controllable sources will be equal to the TMDLs. This intention can also be realized by simply multiplying the flow rate associated with that load by the water quality standard. Reviewer thinks that natural (uncontrollable) sources may contribute a sufficiently high load so the FIB levels will remain high in the watershed. Simulating the effect of various controllable load reductions can help predict the outcome of improvements in wastewater collection systems and stormwater systems.

Staff response: Staff agrees that uncontrollable sources may be a significant contribution to the entire load of fecal indicator bacteria. Staff also acknowledges that modeling approaches may predict what those uncontrollable loads are. However, staff did not have sufficient data necessary to run and calibrate a model to make this prediction, e.g. the flow rate. Therefore, staff is proposing maximizing reduction of controllable sources of fecal indicator bacteria. Staff may consider an evaluation of the uncontrollable fraction after maximum reduction of controllable sources.

Reviewer comment: The Water Board may wish to anticipate how direct pathogen measurements can be used to meet TMDL targets by allowing for alternate expression of mass loadings once quantitative pathogen data become available on a more routine basis. Thirteen years planned for achieving the TMDL is a long enough period to envision a mechanism for incorporating other pathogen indicators (such as concentrations of actual pathogens) into the calculations intended to estimate public health risk.

Staff response: Staff will consider alternative measurements and modeling mechanisms as data and resources become available.

Reviewer comment: Even if simulation tools are not employed, simple calculations for TMDL allocations can be conducted that express TMDL values in terms of number of FIB per day. An example of TMDL allocation is shown on pp. 7-4 to 7-7 in Protocol for Developing Pathogen TMDLs (2001) where the TMDL was calculated

based on allowable concentration at the mouth of the river.

Staff response: The reviewer is referring to calculations to determine mass-based loading of fecal bacteria indicators, in this case, fecal coliform. The calculations require historic stream and/or discharge flow volume. Staff concluded that flow data and watershed specific conditions made the development of a mass-based TMDL problematic, for reasons noted in comments above. However, if sufficient flow volume data was available to staff during TMDL development, staff is confident that the resulting implementation would not be different than currently proposed, i.e., the same responsible parties and allocations would be identified. Staff will consider assessing loads during the implementation phase of the TMDLs if the resources and data necessary to run such a model become available.

Reviewer comment: Another reason for expressing TMDLs in terms of mass loadings is that exceedances of natural (uncontrollable) sources do not automatically lead to additional required action in terms of source monitoring and TMDL modifications if at the same time controllable sources are lowered sufficiently. In other words, the receiving water quality in segments of the watershed or estuary that contain discharge from both controllable and natural sources may be qualified and controllable sources can compensate for exceedance elsewhere. As a result the watershed is still in compliance with the TMDL.

Staff response: The reviewer's comments refer to a mass-based TMDL. For reasons stated previously, staff proposed a concentration TMDL. With regard to the above reviewer comments, staff will consider using modeling approaches during the implementation phase if resources and data become available. Modeling during the implementation phase may inform the progress of achieving the TMDLs and result in a more precise distinction between uncontrollable and controllable sources.

Reviewer comment: It is stated that the Margin of Safety (MOS) is set implicitly by setting the TMDL equal to the WQS. If the Water Board decides to change the way the TMDL is calculated by defining it on a mass basis, it would be useful to include a separate MOS a certain percentage point lower than the WQS of a geometric mean for those allocations, which are clearly predominantly of human origin.

Staff response: Staff chose not to define the TMDLs on a mass basis.

Implementation Plan

Reviewer comment: The proposed approach to first target controllable sources of anthropogenic origin is feasible and supported by previous monitoring and source identification studies in the watershed. The proposed Implementation Plan takes into account that additional measures may be necessary based on site-specific objectives.

Staff response: Staff agrees. The strategy is to first target controllable sources of fecal indicator bacteria during the implementation phase while assessing the feasibility of achieving the allocations during implementation.

Monitoring Plan

Reviewer comment: The proposed general monitoring plan is feasible and includes specific stormwater outfalls. There is one remaining uncertainty for the adaptation of monitoring plans in case of continuing exceedances of WQO after controllable sources have been reduced or eliminated. The potential for re-growth of microbial indicators in the watershed is largely unknown. It is uncertain that mere monitoring of water quality using FIB could address this possibility. Such a monitoring program may involve a research component ("Feasibility` of re-growth of microbial indicators in situ in Pajaro River Watershed") and would benefit tremendously if real pathogen data were collected at the same time.

Staff response: Staff agrees that a study to address potential re-growth would be valuable. The implementation plan does not require responsible parties to study potential fecal indicator bacteria re-growth. However, staff would consider results of such a study during the implementation and assessment phase of the TMDLs.

Reviewer comment: It is therefore recommended to include measurements for pathogens (e.g. human Adenoviruses and Enteroviruses) in monitoring activities whenever feasible and especially when a presumptive hotspot of WQO exceedance has been identified. Such monitoring activity can use PCR-based methods for detection of pathogens as long as proper QA/QC procedures are followed. Further, the Water Board is advised that microbial source tracking (MST) methods have undergone significant developments since 2002, when the Morro Bay Estuary study was completed. In addition to ribotyping methods there are available library-independent approaches, which have been widely used in California and have been shown to be geographically independent in the state. Selected monitoring of watersheds with MST methods that target animal host-specific genetic fecal markers with fast decay rates in the environment can identify fecal contamination that is of recent origin. In other words, it may be more beneficial to combine fecal coliform monitoring with MST to verify that exceedances truly reflect a recent fecal contamination event. Costs for quantitative PCR assays on extracted DNAfrom water can be as low as 100 USD per assay, depending on sample volume filtered and method used. Generally, the individual assay rates decrease when several assays are performed on the same DNA extract. Consequently, costs for MST analysis are almost comparable to those of FIB tests for implementation and monitoring purposes.

Staff response: Staff agrees MST methods would be useful to assist staff in determining the source and vintage of fecal contamination. As part of adaptive implementation efforts, staff will consider adding MST to the monitoring plan, if

appropriate and as the technology becomes more accurate and affordable, as the reviewer has noted.

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Time schedule for achieving the TMDLs

Reviewer comment: The proposed timeline is reasonable.

Staff response: Staff agrees.

General conclusions

The reviewer made general comments directed at three TMDL projects. The three TMDL projects had similar analysis approaches and findings. Most of the general comments are addressed specifically in the comments and responses above. The following are comments and staff's response to those not yet addressed.

9. Reviewer comment: The proposed measures to reduce allocations from controllable sources are supported scientifically and may be adequate to achieve necessary load reductions and compliance with a mass-based TMDL.

   Staff response: Staff agrees.

10. Reviewer comment: Sampling campaigns should include a sufficient number of wet events during the implementation and monitoring phases.

Staff response: Staff agrees. Staff will insure that wet-event sampling occurs during the monitoring phase.